Eye on the Sky

National Weather Service
Louisville, Kentucky
Newsletter

Spring 2000
Volume 1, Number 1

A Message from the Boss

Welcome! We are proud to add this new means of communicating with our core spotters and the emergency managers.

In recent years, the modernization of the National Weather Service has received much publicity. We have added Doppler radars and state-of-the-art computer technology to diagnose the atmosphere, track weather systems, and improve our forecasts and warnings. From my perspective, the taxpayers' money has been well spent since we have improved our services. Of course, there's always room for improvement in our forecast and warning programs.

Forecasts are prepared using the Advanced Weather Interactive Processing System (AWIPS), sophisticated and highly interactive computers that allow for multiple data integration. Warnings are our "bread and butter" so our staff is highly trained to provide effective watches, warnings, and statements as needed to promote the protection of life and property. They use the powerful WSR-88D Doppler radar and our computers to analyze storm structure and issue warnings. We spend time in ongoing training to further improve our warning program, much more so than we did 20 years ago. This is our "internal" effort.

Attention! Welcome to the first NWS Louisville's "Eye on the Sky" newsletter!

However, there is also an important "external" effort. We issue almost all of our warnings based on radar. If we wait until a severe storm or a tornado strikes to issue a warning, then this is too late for people to take necessary precautions. So, do we still need "ground truth" reports? We certainly do! Our computers inform us when the atmosphere is primed for severe weather, and our radar displays signatures that suggest when warnings are needed. However, we still cannot be absolutely sure that damaging wind, large hail, or a tornado actually is occurring until a human being contacts us to let us know.

This is where storm spotters come into play. After forecasters issue warnings, they need accurate reports to help guide them in their warning decisions for additional counties downstream. What about receiving reports a day or two later? These also are very useful for our verification and training programs. We save important radar pictures, then review them later to determine how various radar signatures correlated to severe weather reports. This helps forecasters know what features to key in on during the next event.

We consider storm spotters and emergency managers our partners! We are a relatively small Federal agency (about 4800 people nationwide) with a big responsibility. We need your trained eyes to tell us what is going on "out there." We value our professional relationship with you and hope to continue to build mutual trust in the future!

I hope you will enjoy this first issue of "Eye on the Sky" and all future issues as well. Let us know your comments. Thank you!

Marvin Maddox
Meteorologist-In-Charge
NWS Louisville

Inside this issue:

Overview of WSR-88D Doppler Radar

The NWS's Weather Surveillance Doppler Radar (WSR-88D) is a highly sensitive, powerful, and invaluable technology. Key components of the system include the Radar Data Acquisition antenna that senses the atmosphere, the Radar Products Generator that creates numerous radar products, and the Principle User Processor workstation where data is displayed. The WSR-88D shows the location, intensity, and movement of precipitation, from which it can sense motion (i.e., velocity) in the atmosphere directed toward and away from the radar (i.e., the Doppler effect). Velocity data helps in assessing atmospheric wind fields and severe weather velocity signatures from thunderstorms. The WSR-88D also provides estimates of precipitation, important in assessing flash flood potential, and many other products. The Doppler radar greatly enhances the ability of NWS forecasters to

Overview of WSR-88D Doppler Radar (continued)

evaluate thunderstorms and their trends in order to issue timely and accurate warnings during severe weather events. It also allows meteorologists to issue effective short-term forecasts for any weather situation. However, the radar cannot determine for sure if severe weather is occurring, it only displays signatures associated with severe weather. In addition, there can be slight target sampling problems at distant ranges. Thus, accurate spotter reports also are critical to assist in the storm analysis and radar signature verification processes. A few of the basic WSR-88D products available to NWS forecasters are described briefly below.

Base Reflectivity: Used extensively to identify the location, intensity, pattern, and movement of precipitation, from snow flurries to heavy rain and hail. Reflectivity data provides a wealth of crucial information needed to issue accurate severe weather warnings. High reflectivity values denote that heavy rain and possibly hail are occurring within thunderstorms. The radar generates reflectivity data at various levels, allowing assessment of the vertical structure of thunderstorms. In winter, reflectivity data clearly shows snow, from flurries to bands of heavy snow and sleet.

Base (Ground-Relative) Velocity: Measures atmospheric wind fields directed toward and away from the radar (i.e., "radial" winds). Base velocity is important for detecting strong straight-line winds from thunderstorms, and overall wind flow patterns in the atmosphere. To better conceptualize ground-relative velocity, consider this example: if a person stood outside and did not move, the wind velocity that person felt would be "base" or "ground-relative," i.e., the actual wind in the atmosphere. Single Doppler radar only can assess wind components directed toward and away from the radar. However, from these radial winds, actual wind patterns often can be deduced.

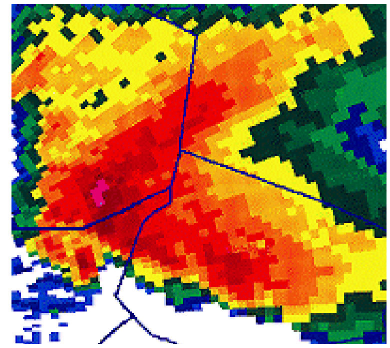
Storm-Relative Velocity: Measures winds relative to a moving precipitation target (e.g., a thunderstorm). In other words, it is the wind that a thunderstorm actually "feels" as it moves through the environment. It is calculated by combining the motion of the storm with the actual wind. Storm-relative velocity is critical for detecting shear zones, mesocyclones (rotating updrafts), and converging and diverging wind fields within severe thunderstorms that could result in damaging surface winds, hail, and even tornadoes. To better conceptualize storm-relative velocity, consider this example: if a person rode a bike outside (i.e., was moving), the wind velocity that person felt while moving would be "storm-relative" (combines the actual wind with the movement of the person), i.e., different from the actual or "ground-relative" wind.

Reflectivity and Velocity Vertical Cross-Sections: Allow forecasters to assess the vertical structure of thunderstorms. Critical factors that can be analyzed include the echo top height, storm tilt, height and depth of high reflectivity values, airflow patterns within and near a storm, and the life cycle stage of a storm.

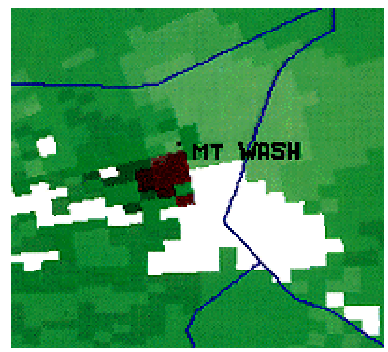
Vertically Integrated Liquid (VIL): A vertical integration of reflectivity values within the entire depth of a thunderstorm, i.e., a type of measure of the amount of liquid and ice within a storm. This parameter allows forecasters to monitor storm severity trends as well as the potential for large hail.

Precipitation Estimates: The radar estimates hourly and storm total precipitation amounts. As an augment to ground-truth rain gauges and spotter reports, this information is crucial in determining the potential for flooding and flash flooding. There are a few accuracy limitations, but overall the radar does a good job in determining amounts and locations of precipitation.

Velocity Wind Profile (VWP): A radar estimation of wind speeds at specific altitudes in the atmosphere as a function of time. The VWP product allows forecasters to assess vertical wind



WSR-88D base reflectivity image showing a large supercell thunderstorm that produced a strong tornado in northeast Bullitt County, Kentucky (southwest part of storm) on May 28, 1996. Large hail and heavy rain also occurred (within darker shades in storm). WSR-88D pictures actually are all in color.



Storm-relative velocity image showing a tornado-producing mesocyclone over northeast Bullitt County, Kentucky (near Mt. Washington) on May 28, 1996 (same time as reflectivity image above). The dark (light) shades are winds directed away from (toward) the radar located to the west (left) of the image. Thus, a strong cyclonic (counterclockwise) circulation is evident.

shear (speed and directional shear) in the environment, which is crucial to the organization and severity potential of thunderstorms, assuming sufficient moisture, instability, and lift are present to form storms. Vertical speed shear refers to increasing wind speeds with height. Directional shear refers to a change in wind direction with height.

For additional information on the WSR-88D, including pictures, example data fields, and radar imagery from selective severe weather events in Kentucky and southern Indiana, visit the Science and Technology section of our Web site at **www.crh.noaa.gov/lmk/soo/index.html**.

Ted Funk — *Science Officer*
Rob Cox — *Meteorologist*

Tornado Season Approaching

Prime tornado season is fast approaching. The majority of tornadoes across Kentucky and southern Indiana occur during April and May. About 10-15 tornadoes are reported annually in Kentucky with 20-25 in Indiana. The greater number of tornadoes in Indiana may be due to a denser population and/or to a more preferred storm track.

Tornadoes take many shapes and sizes. They can vary from several feet wide up to 1 mile in width and pack winds around 300 mph. Twisters are classified as either weak, strong, or violent. Violent tornadoes make up only 2 percent of all tornadoes, but account for 70 percent of all tornado deaths. These tornadoes are born from supercell thunderstorms such as the one that hit Bullitt and Spencer counties in north-central Kentucky on May 28, 1996. Early warning, excellent reports, widespread media coverage, and proper public response prevented any fatalities on that day.

Tornadoes are classified based on the Fujita damage (primarily to buildings) scale. Dr. Theodore Fujita, the late famed severe weather researcher, developed this tornado rating based on their intensity:

Fujita Damage Scale:

(F0) Weak Tornado	40-72 mph
(F1) Moderate Tornado	73-112 mph
(F2) Significant Tornado	113-157 mph
(F3) Severe Tornado	158-206 mph
(F4) Devastating Tornado	207-260 mph
(F5) Incredible Tornado	261-318 mph

Tornado Facts and Safety Rules:

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. A funnel cloud also is rotating air, but **not** in contact with the ground. Experienced spotters know that a number of features can bear a resemblance to a tornado or funnel cloud, including rain shafts and scud clouds. **Rotation** about a vertical axis is characteristic of a tornado or funnel cloud but not a look-alike. Spotters should look for the following environmental clues that often precede a tornado:

Dark, often greenish sky
Large hail
Rotating wall cloud (a lowering of an isolated cloud attached to a rain-free base)
Loud roar (similar to a freight train).

Occasionally, tornadoes develop so rapidly that advance warning is not possible. Remain alert for signs of an approaching tornado such as a debris cloud. Flying debris is responsible for most deaths and injuries. If a tornado is spotted or a warning issued, move to a pre-designated shelter in your home such as a basement or an interior room or hallway on the lowest floor. Abandon mobile homes, even if tied down, for they offer little protection from tornadoes.

Don Kirkpatrick
Severe Weather Meteorologist

Eye on the Sky is a quarterly newsletter published by NWS Louisville for the benefit of our core spotters and the Emergency Managers in our county warning area. We will include articles that provide useful seasonal information to you. Comments and suggestions are welcome. Please contact us by email at w-lmk.webmaster@noaa.gov.

Ted Funk and Van DeWald
Chief Editors

NWS Louisville on the Web

Over the last several years, Internet use nationwide has grown exponentially, with technology and data transfer rates improving at a remarkable pace. What once was considered a private, government communications network long ago has now become widely available to the general public in homes, businesses, local and state government offices, churches, schools, and libraries. The Internet has become an invaluable tool and a wonderful resource!

For nearly four years, the National Weather Service in Louisville has had a Web site available on the Internet at **www.crh.noaa.gov/lmk/index.html**, providing yet another way for the public to access our products and services. One of the first NWS sites developed, our Web site offers a wealth of information, including links to all of the forecasts and warnings we issue, links to satellite and radar imagery, climatological data, weather preparedness information and safety tips, spotter reference charts, guides to frequently used terms, and much meteorological science and technological information.

However, the Web server may not be available 24 hours a day, 7 days a week due to situations beyond our control. Timely delivery of data and products from our Web site through the Internet is not guaranteed at this time. The information on government servers is in the public domain, unless specifically annotated otherwise, may be used freely by the public, and is not subject to copyright protection. Before using information obtained from Internet weather servers, special attention should be given to the date and time of the data being displayed.

We hope you visit our Web site often and find the information both useful and informative. If you have any comments, questions, or concerns, please feel free to email us at: **w-lmk.webmaster@noaa.gov**.

Storm Reports via the Internet:

The National Weather Service needs to know what's going on in your home town! We would like as much detail as possible, especially if you have experienced tornadoes, wall clouds, funnel clouds, high wind, wind damage, hail, lightning damage, heavy snow, sleet, freezing rain, heavy rain, flooding, dense fog, or any other unusual weather phenomenon. This information is extremely important and will be used for verification and training purposes so that we may better serve you in the future by providing better warnings and forecasts. With all of the technology that we now possess, your reliable storm reports still are a great and essential asset!

Internet storm reports may or may not be monitored on a real-time basis. For real-time reports, please call the National Weather Service directly using our toll free number, which is answered by staff meteorologists 24 hours a day. However, electronic storm reports still are very useful for providing further storm detail and to submit additional delayed reports as you receive them. Storm reports a day or two, or even a week after an event still are extremely useful and requested.

Please check out our Internet storm report submission form at: **www.crh.noaa.gov/lmk/storm_report.htm.** Please fill out the form providing as much detail as necessary to accurately describe the situation. If additional information is needed, we may need to contact you to verify data or obtain further clarification.

Van DeWald
Meteorologist/Webmaster

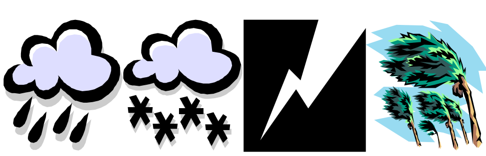
1999 Severe Weather Season in Review

In contrast to the previous several years, Spring 1999 was a relatively inactive severe weather season. Five tornadoes were reported in central Kentucky and south-central Indiana, but all were small and did only spotty damage. On May 5, a small tornado touched down briefly one mile north of Auburn in Logan County, Kentucky. On May 17, three small tornadoes made brief ground contact, including one in Birdseye in Dubois County, Indiana and two others in Eckerty in Crawford County. The year's last tornado was on August 19, two miles north of Crab Orchard in Lincoln County, Kentucky. No deaths or injuries were reported with any of the tornadoes.

A busy month in 1999 for severe thunderstorms, interestingly enough, was January. Storms that month resulted in three injuries. Two other injuries were caused by a July thunderstorm.

Of course, as we progressed through Spring and Summer 1999, we also experienced hot weather and drought conditions, which helped explain the lack of severe weather and tornadoes.

Norm Reitmeyer
Warning Coordination Meteorologist



No matter what the weather, we're always ready!

Spring 2000 Outlook

With the increased understanding of El Nino and La Nina in the equatorial waters of the Pacific Ocean and their impact on global weather, seasonal weather outlooks have become more popular in the United States.

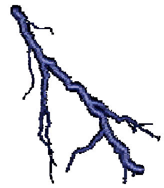
Remember all the talk about El Nino a couple of years ago and how the experts said it would result in floods in California and along the Gulf of Mexico coast? Well, it happened and much was made of how the preparedness efforts saved lives and property.

The official Spring 2000 outlook will be out soon. What will it say for the Ohio and Tennessee Valleys? How much severe weather and tornadoes can we expect? Last year, above normal severe weather was expected based on the La Nina pattern. However, we had a relatively "quiet" season, with no major outbreaks. In fact, the severe weather outbreak in early January 2000 was more widespread than any event in Spring 1999.

This suggests that long range outlooks must be approached carefully. Remember, outlooks and longer term trends provide general overviews and are not intended to forecast day-to-day weather systems. With La Nina still in place in the equatorial Pacific, it is possible that an active severe weather season again will be predicted for our area. But, will it occur? No matter what this spring has in store, rest assured that NWS Louisville meteorologists will be prepared and will do their best to issue timely and accurate warnings and forecasts.

Norm Reitmeyer
Warning Coordination Meteorologist

Lightning Safety Rules



While only about 10 percent of all thunderstorms become severe, EVERY thunderstorm produces lightning. Lightning is dangerous and causes an average of 93 deaths each year. People outdoors are most at risk from lightning, especially those under or near tall trees, in or on water, or on hilltops.

Remember, if you can hear thunder, then you are close enough to a thunderstorm to be struck by lightning. Go inside a safe shelter immediately, such as a sturdy building or a car. However, do not take shelter in small sheds, under isolated trees, or in convertible automobiles. Get out of boats and away from water. If you are caught outdoors and no shelter is nearby, find a low spot away from trees, fences, and poles. Make sure the location is not subject to flooding. If you are in the woods, take shelter under short trees. If you feel your skin tingle or your hair stand on end, then squat low on the ground on the balls of your feet. Make yourself the smallest target possible and minimize contact with the ground.

Check the weather forecast before leaving for extended periods outdoors. Postpone outdoor activities if thunderstorms are imminent. Check on those people who may have trouble taking shelter if severe weather or lightning threatens.

Norm Reitmeyer
Warning Coordination Meteorologist

The NWS Flood Program

The National Weather Service, besides being the federal agency responsible for issuing severe thunderstorm and tornado warnings, also is responsible for issuing all flood and flash flood warnings. In fact, the NWS has been in the "flood business" for as long as it has been forecasting the weather. In many cases, the National Weather Service's records of river stages go back farther than records from the U.S. Geological Survey and the U.S. Army Corps of Engineers. Today, these three federal agencies, along with various state agencies, keep a close watch on rivers and streams.

When too much water causes, for example, roads to become submerged or streams to rise above their banks, the NWS kicks into action by issuing flood warnings. There are basically two types of flood warnings, i.e., flash flood warnings and river flood warnings.

Flash floods warnings are issued on a county basis where rapid flooding is expected due to very heavy rainfall amounts in a short time period or possibly even a dam break. However, usually no attempt is made to determine how deep the water will be. River flood warnings are issued for certain locations called forecast points, where the river will exceed a pre-determined flood stage. River flood warnings are much more specific and forecast not only the height of the flood crest, but the time of the crest as well. River flooding is not as rapid as flash flooding, but can last longer.

Although the threats of severe weather cannot be overemphasized, more people lose their lives due to flooding in this country than by any other weather related cause (including tornadoes and lightning). Most deaths are caused by driving into flooded areas. Flooding also is the number one weather related cause of property damage in the U.S., and most federal disaster declarations are the result of flooding.

More people lose their lives due to flooding than by any other weather related cause.

To protect yourself from the dangers of flooding, follow these safety tips. Never attempt to cross a flooded roadway by vehicle or foot. The water may be too deep to allow safe passage. If you are in a flood-prone area and a warning is issued, leave the area as soon as possible. In the case of a flash flood, you may only have minutes before high water reaches you. If you are asked to evacuate, do so at once. After the flood is over, avoid contact, if possible, with any flood water or mud since it may be highly contaminated.

Mike Callahan
Service Hydrologist

Winter 1999-2000 Weather Summary

The Winter 1999-2000 season started slowly as mild conditions prevailed across central Kentucky and south-central Indiana through mid December. Later in the month, however, temperatures dipped closer to normal, and on Christmas Eve, Louisville and Lexington both received their first significant seasonal snowfall. At the National Weather Service office in Louisville, 4.5 inches of snow fell while 1.6 inches was recorded at Lexington. Above normal temperatures returned on the last three days of December, which melted all snow on the ground by New Year's Eve.

The new millennium began unusually warm as high temperatures soared to 15-30 degrees above normal from January 1-3 over most of the area. On January 3, the warm air clashed with cold air to the north to create severe thunderstorms, tornadoes, and flash flooding over much of the area. An F0 tornado touched down in southern Washington County, Indiana and destroyed a mobile home. The storm also caused roof damage to a house and barn. In addition, tennis ball size hail occurred in Jeffersonville, Indiana and silver dollar size hail in Louisville. Trees and power lines were reported blown down over many counties in central Kentucky and southern Indiana.

While mild temperatures continued through the first half of January, winter-like conditions returned for the second half. One to two inches of snow fell across south-central Indiana and north-central Kentucky on January 19. Another storm produced snowfall amounts of 1-4 inches across south-central Kentucky on January 22. The morning of January 29 brought a mixture of sleet, freezing rain, and snow to central Kentucky. Meanwhile, heavy snow fell over south-central Indiana with up to 4 inches reported in Dubois, Washington, and Crawford counties. Below are temperature, precipitation, and departure from normal data for December 1999 and January 2000 for Louisville, Lexington, and Bowling Green.

	Avg. Temp (F)		Departure from Normal (F)		Precipitation (in.)		Departure from Normal (in.)	
	Dec.	Jan.	Dec.	Jan.	Dec.	Jan.	Dec.	Jan.
Louisville	38.1	33.7	+1.4	+2.0	5.64	5.51	+2.00	+2.65
Lexington	37.3	31.9	+1.4	+1.1	2.70	3.40	-1.28	+0.54
Bowling Green	40.7	35.8	+2.9	+2.9	4.06	3.04	-0.97	-0.78

February's temperatures averaged near normal for the first half of the month. Precipitation was quite sparse through February 12, however, a spring-like storm brought rain and thunderstorms to the area on February 13. At NWS Louisville, 1.81 inches of rain fell, while Frankfort reported 2.09 and Lexington 1.32 inches. Ponding of water occurred, but no significant flooding. For the year 2000 through February 15, Louisville reported 7.33 inches of rain, while Lexington totaled 4.68 and Bowling Green 3.75 inches. What kind of weather will late February and March bring? Time will only tell, but as we transition to spring, some significant swings in temperatures and precipitation are likely.

Steve Marien
Meteorologist

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